An Interactive Virtual Training (IVT) Simulation for Early Career Teachers to Practice in 3D Classrooms with Student Avatars

A. Delamarre[a,b]/C. Buche[b]/M. Polceanu[b]/S. Lunn[a]/G. Ruiz[a]/S. Bolivar[a]/E. Shernoff[c]/C. Lisetti[a]
[a]Virtual Interactive Social Agents Laboratory, FIU, USA
[b]LAB-STICC, ENIB, France
[c]Graduate School of Applied and Professional Psychology, Rutgers University, USA
adela177@fiu.edu; buche@enib.fr; polceanu@enib.fr; slunn002@fiu.edu;
gruiz044@fiu.edu; sboli001@fiu.edu; elisa.shernoff@rutgers.edu; lisetti@cs.fiu.edu

Abstract

Interactive Virtual Training (IVT) is a web-based interactive simulation system created to help early career teachers working in high-poverty schools learn effective classroom management skills. IVT simulates disruptive students' behavior (aggressive, off-task, noncompliant), as defined in vignettes developed by pedagogical experts on our team. These simulations enable early career teachers to hone their classroom management skills *before* they start teaching in real classrooms. In the simulation, users will interact with thirty (30) realistic diverse virtual three-dimensional (3D) "practice" students, which are situated in two (2) realistic virtual 3D classrooms. We describe IVT: (1) requirements and process mechanisms, (2) the IVT simulation of the vignettes depicting students' behaviors, (3) 3D virtual classrooms and characters, (4) website main functionalities, and (5) contributions and challenges.

Introduction

Learning how to prevent and manage behavioral problems is critical to improving student achievement, particularly for struggling learners. This includes students growing up in high poverty communities, in addition to students at risk for emotional and behavioral disabilities (Oliver and Reschly 2010). Effective prevention and management of disruptive behaviors has been empirically linked to student success through its impact on effective instruction and maximizing of learning opportunities (Creemers 1994; Crone and Teddlie 1995).

Early career teachers (ECT) with less than 3 to 5 years of experience report that disruptive behaviors are stressful, given they have received limited training in this area (Shernoff et al. 2011; 2016). Predictably, disruptive behaviors are identified as one of the strongest drivers of turnover (Ingersoll and Smith 2003; Shernoff et al. 2016). ECTs are often left to practice and improve these skills in the classroom without support, and solely through a trial-and-error approach. Given the negative impact that disruptive behaviors can have on classroom climate and interpersonal relationships, helping ECTs improve these skills can have a significant impact on classroom interactions and the facilitation of student learning.

Progress in three-dimensional (3D) computer graphics, visual displays, and auditory stimuli have made it possible to develop virtual environments inhabited by realistic human-like characters (Magnentat-Thalman and Thalmann 2005). 3D virtual characters (also known as virtual agents, virtual humans, or avatars) can simulate human behaviors and affective expressions by adapting and responding to the behavior of their human counterparts (Calvo et al. 2015). The effectiveness of serious games for professional training has already been shown in applications such as training safe drivers (Herviou and Maisel 2006). Presently some training systems do simulate students in schools (Popovici et al. 2004) as well as teachers with the STAR Simulator (Dieker et al. 2007). However these studies do not tackle the ECT issues that we address and has some limitations that we do satisfy.

Interactive Virtual Training (IVT) aims to accelerate ECTs' skill acquisition by tackling ECTs' main issues: ECTs are unprepared for the realities of teaching (Grossman and McDonald 2008), ECTs have few opportunities to practice while receiving feedback about their mistakes expertly tailored to them (Denton and Hasbrouck 2009), and ECTs have few opportunities for reflecting about their skills and how to resolve problems (Reigeluth and Carr-Chellman 2009). IVT is a four year development and innovation grant funded by the US Department of Education.

IVT is an educational system in which ECTs can improve their classroom management skills by practicing in a realistic 3D virtual classroom. In IVT, ECTs are provided with a large number of possible options in response to the actions of disruptive student avatars (e.g. praise or ignore student) which they can select. Their choice, dynamically determines the avatars' next behavior: the classroom climate can, as a result, get worse or improve based on the ECTs' choice.

In this article, we describe (1) IVT requirements and classroom vignettes developed in collaboration with project education experts, (2) the IVT simulator architecture controlling the interactive vignettes of students

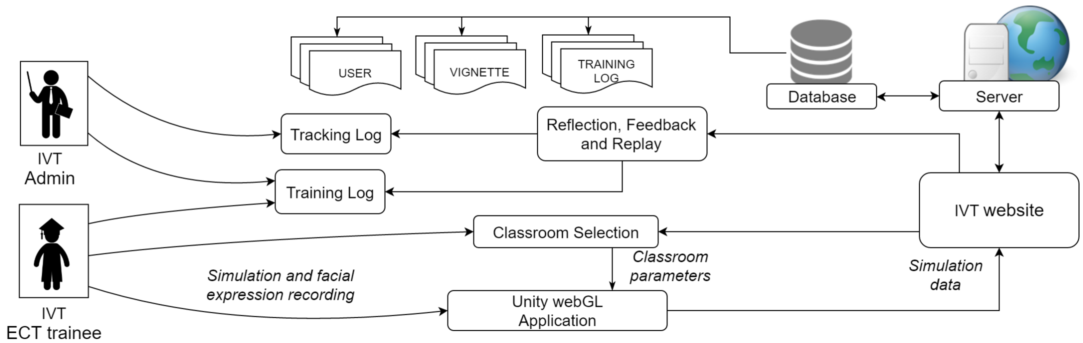

Figure 1: Overview of the IVT system

behaviors and ECTs' possible choices, (3) the creation of IVT 3D virtual classrooms with its avatars, (4) IVT website main functionalities and visual prototype, and (5) contributions and challenges.

IVT Specifications and Phases

The strength and novelty of IVT is that it addresses some of the limitations of existing virtual training model for teachers (Dieker et al. 2007). *First*, IVT provides ECTs with learning experiences in which they are encouraged to practice, reflect, and problem solve by enabling ECTs to replay simulations of their IVT session, and to learn from their mistakes. *Second*, with its online access and low-technology requirements, IVT facilitates ECTs practice and receiving automatically generated explicit feedback about their skills which can be advantageous in the resource-limited environments of high poverty schools. *Third*, IVT classrooms are populated with a realistic number of avatars, who behave autonomously (rather than being controlled by a human) with, not only disruptive behaviors, but also compliant ones.

Specifications

IVT is built on four main components:

- **Vignettes**: Vignettes are descriptions of possible classroom scenarios designed to reflect the real life situations that teachers experience, created by our team of pedagogical experts.
- **Classrooms**: To ensure the immersion of ECTs in our two IVT classrooms (one 1^{st} grade, one 6^{th} grade), our 3D graphics focus on physical arrangement, quality, and realism.
- **Characters**: Each classroom is populated with 15 avatars. Characters were designed to not only reflect appropriate ages (1^{st}graders and 6^{th}graders) but also to portray the racial and ethnic demographics typical in high poverty schools.
- **Website**: ECTs will access the system using the IVT website where they can play and replay simulations, enter comments and reflections, and view simulation results.

Phases

In order to achieve our objectives, IVT training is divided into two phases:

- **Phase 1 IVT Practice:** During the practice phase, skills of the ECT, like monitoring and redirecting of disruptive behaviors are trained and tested. ECTs are invited to practice with a trial-and-error approach. Feedback is provided at the end of the simulation by revealing the type of strategy a teacher selected, effectiveness of the choice made, session duration and decision making time.
- **Phase 2 IVT Playback:** The playback phase involves reflection and problem solving in order to facilitate learning and knowledge transfer. ECTs are encouraged to share their feelings and to comment about their choices. Furthermore, facial expressions recorded during simulation are shown during the replay session, so that ECTs can observe their own facial expressions (e.g., shocked or lost) in reaction to the various situations, just as their students would observe during a real-life class. This is particularly important since some expressions may reinforce disruptive behaviors.

The computer process is described in Figure 1. During the practice phase, after selecting a classroom on the website, the ECT is directed to a webGL simulator generated by Unity. The webGL simulator utilizes the input parameters of the selected classroom (vignette, level, behaviors etc.). Then the ECT's actions are recorded along with his/her facial expressions through a web-cam. Once a final node is reached in the simulation, this data is sent back to the database through the IVT website. During the playback phase, ECTs receive feedback on their choices and can replay simulations, and they can reflect on decisions made.

IVT Simulator

From the vignette to the simulation

This section explains the procedure required to implement a vignette, and to produce a simulation scenario. In order to achieve this, we use a framework called

MASCARET, which establishes a flow between IVT scenes.

MASCARET framework To develop IVT, we used MASCARET (Buche and Querrec 2011), a meta-model able to provide a description of a virtual learning environment by interpreting UML concepts. MASCARET provides us with a fast way to implement vignettes using an UML modeling software. Simplification of these vignettes is very important considering the vignettes' massive initial size; Each vignette contains approximately 50 pathways, and each pathway contains approximately 20 actions/events. The use of MASCARET is, therefore, essential for IVT.

Vignettes illustrate the potential sequence of interactions between the ECT and the student avatars. They can be implemented as an UML activity diagram provided by MASCARET; Each action leads to another consequence, which follows the vignette flow.

The activity diagram which represents a vignette is then transferred into the IVT simulator. When the simulation is launched, MASCARET loads the vignette through the activity diagram so that the sequence of actions can then be played. This process allows a semi-automatic implementation of the vignettes in a virtual environment.

Scene In IVT, a scene (Fig. 2) is an ordered sequence of actions and choices realized by the different protagonists of the classroom according to vignette flows. Proposed choices allow ECTs to practice monitoring and redirecting the disruptive avatars of the situation. During the progression of the simulation, disruptive behaviors are minimized when the ECT makes effective choices. Conversely, the student becomes more unruly when less effective decisions are made. Once a choice has been selected, the corresponding action is automatically executed and the simulator starts performing the sequence following a given choice. The simulation alternates between sequences of actions and decision nodes until a final completion node is reached.

Figure 2: IVT Scene - Drum solo pathway

IVT Environment

Classroom Two 3D classrooms were designed for IVT, one 1st grade and one 6th grade. Multiple prototypes were developed and vetted by six educators with extensive experience working in high-poverty schools. Their feedback and recommended revisions helped ensure both classrooms were realistic and authentic. Accordingly, to provide an immersive experience the classrooms also required a high level of realism. Thus, special features like wall decorations, desks and chairs, and furniture arrangement were carefully considered to enhance the verisimilitude according to the grade.

Characters A total of 30 unique avatars (Fig. 3) were generated to accurately depict diverse students. Motion-capture technologies were used to animate them, audio recording was employed to record children's voices, and Unity navigation system was used to create the virtual boundaries. Moreover, each student in the classroom was assigned a specific behavior. There are two kinds of behaviors:

- Disruptive: A disruptive avatar can be off-task (OT), I.E. daydreaming or looking out the window, or aggressive/non-compliant (A/NC), refusing to follow instructions or exhibiting hostile behaviors (verbal and/or physical). From the set of avatars generated for each classroom, a subset of four disruptive ones were implemented, OT and A/NC for 1st grade and 6th grade.
- Non-disruptive: Non-disruptive avatars are controlled by a finite state machine, which loops through behaviors relevant to the context of the vignette story.

Figure 3: IVT Character - Face, body and animation

IVT Website

Previous work by the investigative team documented that ECTs preferred online rather than in person training, so that they could practice at their convenience and not be required to attend professional development during the school day.

Both phases of IVT are contained in the website. Initially, ECTs can practice their behavioral management skills on the two classrooms with three levels of difficulty, and obtain feedback on it after the simulation.

The playback phase allows ECTs to reflect on decisions they made during the simulation. For a chosen simulation ECTs can replay the scene while viewing their own facial expressions which were recorded during the simulation.

Conclusion and Future Work

Difficulties preventing and responding to disruptive behaviors is one of the top reasons why new teachers leave the profession. In this paper, we have presented the IVT system, an advanced training system in which early career teachers working in high poverty schools can hone their behavioral management skills using disruptive avatars in a virtual training environment.

The IVT application goals are to design, program, and gauge the effectiveness of early career teachers' interactions inside a 3D virtual classroom occupied by student avatars. By simulating disruptive children, novice teachers can hone their skills and learn how to manage a challenging classroom behaviors.

The next challenge is to evaluate IVT usability and performance in classroom settings to verify the effectiveness of this system. Previous work has evaluated the effectiveness of virtual learning environments (Annetta et al. 2009; Dorn and Barker 2005), providing objective evaluation data like learning curve formed by the performance of learners (data on the completion time of the task, the number of errors, etc.). Finally, studies have been done to assess the effectiveness of transferring online learning to a real situation (Ganier, Hoareau, and Tisseau 2014; Bossard et al. 2008).

In order to properly evaluate the system, 16 preservice teachers will provide feedback on the usability of the prototype, along with 64 early career teachers. These users will participate across approximately 8 schools (6 in the pilot study).

Acknowledgements

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A150166 to the Rutgers, the State University of New Jersey; And by the National Science Foundation grant award No.IIS-1423260 to Florida International University.

References

Annetta, L.; Minogue, J.; Holmes, S.; and Cheng, M. 2009. Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education* 53(1):74–85.

Bossard, C.; Kermarrec, G.; Buche, C.; and Tisseau, J. 2008. Transfer of training in virtual environments: A new challenge. *Virtual Reality* (12):151–161.

Buche, C., and Querrec, R. 2011. An expert system manipulating knowledge to help human learners into virtual environment. *Expert Systems With Applications* 38(7):8446–8457.

Calvo, R. A. E.; D'Mello, S. K. E.; Gratch, J. E.; and Kappas, A. E. 2015. The Oxford handbook of affective computing.

Creemers, B. P. M. 1994. Effective instruction as a basis for effective education in schools. *Tijdschrift Voor Onderwijsresearch* 19(1):3–16.

Crone, L. J., and Teddlie, C. 1995. Further examination of teacher behavior in differentially effective schools: Selection and socialization process. *Journal of Classroom Interaction* 30(1):1–9.

Denton, C. A., and Hasbrouck, J. 2009. A description of instructional coaching and its relationship to consultation. *Journal of Educational and Psychological Consultation* 19:150–175.

Dieker, L.; Hynes, M.; Stapleton, C.; and Hughes, C. 2007. Virtual classrooms: Star simulator building virtual environments for teacher training in effective classroom management. *New Learning Technology SALT* 4(1):1–22.

Dorn, L., and Barker, D. 2005. The effects of driver training on simulated driving performance. *Accident ; analysis and prevention* 37(1):63–9.

Ganier, F.; Hoareau, C.; and Tisseau, J. 2014. Evaluation of procedural learning transfer from a virtual environment to a real situation : a case study on tank maintenance training. *Ergonomics* 57(6):828–843.

Grossman, P., and McDonald, M. 2008. Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal* 45:184–205.

Herviou, D., and Maisel, E. 2006. ARéViRoad : a virtual reality tool for traffic simulation. In *Proceedings of Urban Transport*, 297–306.

Ingersoll, R. M., and Smith, T. M. 2003. The wrong solution to the teacher shortage. *Educational Leadership* 60(8):30–33.

Magnentat-Thalman, N., and Thalmann, D. 2005. Virtual humans: thirty years of research, what next? *The Visual Computer* 21(12):997–1015.

Oliver, R. M., and Reschly, D. J. 2010. Special education teacher preparation in classroom management: Implications for students with emotional and behavioral disorders. *Behavioral Disorders* 35(3):188–199.

Popovici, D. M.; Buche, C.; Querrec, R.; and Harrouet, F. 2004. An interactive agent-based learning environment for children. In Nakajima, M.; Hatori, Y.; and Sourin, A., eds., *International Conference on Cyberworlds*, 233–240. IEEE Computer Society.

Reigeluth, C. M., and Carr-Chellman, A. A. 2009. Instructional-design theories and models: Building a common knowledge base.

Shernoff, E. S.; Maríñez-Lora, A. M.; Frazier, S. L.; Jakobsons, L. J.; Atkins, M. S.; and Bonner, D. 2011. Teachers Supporting Teachers in Urban Schools: What Iterative Research Designs Can Teach Us. *School psychology review* 40(4):465–485.

Shernoff, E. S.; Frazier, S. L.; Maríñez-Lora, A. M.; Lakind, D.; Atkins, M. S.; Jakobsons, L.; Hamre, B. K.; Bhaumik, D. K.; Parker-Katz, M.; Neal, J. W.; Smylie, M. A.; and Patel, D. A. 2016. Expanding the role of school psychologists to support early career teachers: A mixed-method study. *School Psychology Review* 45(2):226–249.